

Claims

What is claimed is:

1. An apparatus comprising a cassette for controlling movement of blood and separated blood components, the cassette comprising
 - a rigid plastic housing;
 - flexible tube loops extending out of the housing;
 - flexible tubing other than loops extending into, within, and out from of the housing;
 - at least one section of flexible tube within the housing exposed on one side of the housing so that fluid flow through the exposed section can be prevented when pressure is exerted on the exposed section from the exposed side.
2. The apparatus of claim 1 having a hub within the housing adapted to connect sections of the flexible tubes.
3. The apparatus of claim 1 wherein hub is adapted to connect five sections of flexible tubes.
4. The apparatus of claim 1 wherein the side of the housing where the flexible tube is exposed comprises apertures through which pressure can be exerted, and the housing has an opposing side adapted to resist the exerted pressure so as to close off the section of tubing between the aperture and the opposing side of the housing and thereby prevent fluid flow.
5. The apparatus of claim 1 wherein the housing has an opposing side which comprises at least one molded occluder bar which transverses the exposed section of flexible tube.
6. The apparatus of claim 1 wherein the rigid plastic housing has a top section and a bottom section which together form an internal space, the bottom section comprising at least one aperture for accessing the at least one exposed flexible tube section.
7. The apparatus of claim 1 having five tube loops and six apertures.
8. The apparatus of claim 1 wherein the housing has a top section and a bottom section which together form an internal space, the bottom section comprising at least one aperture for

accessing the exposed flexible tube sections, at least one molded occluder bar on the side of the top section facing the internal space and opposed to the aperture, the cassette adapted to allow at least one actuator to selectively close off fluid flow in the exposed section of flexible tubing by pressing the flexible tubing through the aperture and against the molded occluder bar.

9. The apparatus of claim 1 having a filter in fluid communication with at least one flexible tube.

10. The apparatus of claim 1 having six apertures in the bottom section, corresponding molded ridges in the top section opposed to the apertures, and at least one section of flexible tubing between each aperture and each molded ridge; five tube loops; and a hub adapted to connect five sections of tube.

11. The apparatus of claim 1 wherein the cassette comprises a recordable smartcard on which are electronically recorded identification data.

12. A method of making a cassette for controlling movement of blood during a blood separation session comprising

molding a rigid plastic top section with ridges on an underside;

molding a rigid plastic bottom section with apertures and flexible tube guides;

routing flexible tube through guides in the bottom section so that sections of tube traverse the ridges; and

attaching the top and bottom sections so that the sections traversing the ridges are exposed through the apertures.

13. The method of claim 12 further including molding a hub in the top section and attaching flexible tube sections to the hub.

14. The method of claim 12 wherein the bottom section and top section are attached by snap fitting.

15. A method of making a cassette for controlling movement of blood and other fluids comprising molding a rigid tube holder, placing flexible tubing in the tube holder so that at least one section of tubing is exposed and so that fluid flow through the section can be prevented upon pressing the tubing from the exposed side.

16. An apparatus comprising a cassette according to claim 1, a centrifuge bowl for separating the components of a fluid, and at least three flexible tubes between the bowl and the cassette, the bowl comprising

an outer housing, a core connected with said outer housing for rotation therewith; a lower plate; a lumen positioned inside said core extending axially through said core; a first bowl channel within said lumen to said top surface of said lower plate for inflowing said fluid;

a second bowl channel from within said separation volume beneath said lower plate for removing a first separated fluid component, and

a third bowl channel from said separation volume above said lower plate for removing a second separated fluid component;

the tubing comprising

a first flexible tube for inflowing whole blood from the cassette through the first bowl channel to the core of the bowl;

a second flexible tube for removing separated buffy coat or plasma from the bowl to the cassette; and

a third flexible tube for carrying separated red blood cells from the separation volume above the lower plate to the cassette.

17. The apparatus of claim 16 further including an irradiation chamber having a first port and a second port;

a flexible tube for carrying buffy coat from the cassette to the first port of the irradiation chamber;

a flexible tube for carrying irradiated buffy coat from the irradiation chamber to the cassette.

18. The apparatus of claim 16 further including an irradiation chamber having a first port and a second port;

a flexible tube for carrying buffy coat from the cassette to the first port of the irradiation chamber;

a flexible tube for carrying irradiated buffy coat from the irradiation chamber to the cassette;

the irradiation chamber having a rigid first plate having a first surface and a second surface said second surface having a raised boundary surrounding a plurality of raised partitions; a rigid second plate having a first surface and a second surface, said second surface having a raised boundary surrounding a plurality of raised partitions; wherein the second surface of said rigid first plate is contacted with second surface of said rigid second plate thereby forming a chamber; said chamber defined by the raised boundary surrounding the plurality of raised partitions which extend from said second surface of said first plate and said second surface of said second plate, wherein a plurality of channels are formed by said partition providing fluid communication with the first port and second port.

19. An apparatus comprising a disposable kit, the kit comprising

a cassette according to claim 1;

a saline bag inlet tube;

a treatment bag;

a plasma collection bag having an inlet tube for flowing plasma from the cassette and an outlet tube for flowing plasma to the cassette;

an anticoagulant inlet tube for flowing anticoagulant to the cassette;

an irradiation chamber having an inlet tube for flowing buffy coat from the cassette and an outlet tube for flowing irradiated buffy coat to the cassette;

a separation bowl having one tube for flowing blood to the separation chamber and at least two tubes for flowing separate blood fragments from the separation chamber;

means to withdraw blood from a patient comprising a tube for flowing blood to the cassette and means for connecting a needle; and

means to return blood fractions to the patient comprising a tube from the cassette.

20. An apparatus comprising a disposable kit according to claim 19 and a non-disposable tower, the tower comprising

- a controller;
- peristaltic pumps having peristaltic pump heads adapted to engage the pump loops of the cassette and to selectively pump fluid through the pump loops at the command of the controller;
- a deck adapted to engage the cassette and having means to selectively exert pressure on each section of flexible tube through each aperture of the cassette under command of the controller;
- a centrifuge chamber adapted to rotate the separation bowl at the command of the controller; and
- a photoactivation cavity for receiving the irradiation chamber, the irradiation cavity having means to irradiate fluid in the irradiation chamber at the command of the controller.

21. The apparatus of claim 19 wherein the UV irradiation cavity is substantially vertical so that the UV chamber, when inserted in the UV irradiation cavity, has an inlet at the top and an outlet at the bottom of the UV chamber.

22. The apparatus of claim 19, the tower having supports for hanging the saline bag, treatment bag, plasma bag, and anticoagulant bag.

23. The apparatus of claim 19 wherein

- the cassette has five pump loops and five apertures and five corresponding molded ridges opposed to the apertures; and
- the tower has five corresponding pump heads and five corresponding means to selectively exert pressure through the cassette apertures.

24. The apparatus of claim 19 having flexible tubing for whole blood flow from the patient to a vent means in the cassette, flexible tubing forming loops, the loops comprising an anticoagulant pump loop, a whole blood pump loop, a return to patient pump loop, a red

blood pump loop, and a buffy coat recirculation pump loop, and flexible tubing for return of blood fractions and treated buffy coat back to the patient.

25. The apparatus of claim 19 wherein the cassette comprises a recordable, removable smartcard having electronically stored unique identification information and the tower comprises a smartcard reader-writer module, and means for receiving the smartcard in the module, reading the unique identification information to verify compatibility, and means for recording data to the smartcard during a blood treatment or separation session.

26. A photopheresis method comprising:

providing a disposable kit and a non-disposable tower according to claim 19;
withdrawing whole blood from a patient;
adding anticoagulant to form a mixture;
pumping the whole blood-anticoagulant mixture through the cassette to the centrifuge separation bowl;
operating the separation bowl until air in the bowl is displaced into the plasma bag;
collecting separated plasma in the plasma bag while continuing to pump the mixture into the bowl;
mixing plasma with priming fluid;
when a selected amount of plasma is collected, returning plasma to the patient at the same rate as incoming whole blood until red blood cells are detected at a bowl sensor;
withdrawing red cells and pumping at a speed controlled so as to maintain the red cell line at the sensor interface level;
mixing the withdrawn red blood cells with plasma from the plasma collection bag and returning the red blood cells-plasma mixture to the patient;
at a selected time, continuing to pump whole blood into the bowl while discontinuing withdrawing and pumping red blood cells, thereby causing the red blood cells to push buffy coat out of the bowl past the sensor into the buffy coat collection bag until a selected amount is collected;
discontinuing collection of buffy coat when red blood cells have been detected;
injecting photoactivation chemical into the buffy coat in the buffy coat collection bag;
recirculating buffy coat between the collection bag and the irradiation chamber;
irradiating the buffy coat in the irradiation chamber while recirculating;

pumping the irradiated buffy coat from the irradiation chamber;

pumping irradiated buffy coat from the collection bag through a filter in the cassette
and then back to the patient;

rinsing the disposable kit with saline and returning the rinse solution to the patient.